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ABSTRACT

This evaluation of mathematics is one of a series of program evaluations conducted on a cyclical basis in the West Hartford (Connecticut) Public Schools. Its purpose is to provide information for program improvement and growth. The evaluation focused on eight questions, and the findings are organized by these questions, concerning: (1) the extent to which students are learning the mathematics content; (2) how well their achievement compares with other students; (3) sex differences in achievement; (4) how many mathematics courses typically are taken in secondary schools; (5) sex differences in the number of mathematics courses taken; (6) the number of students completing honors and advanced placement mathematics courses; (7) sex differences in these courses; and (8) attitudes toward mathematics. The sources of data used to answer the questions are given, and a summary statement concludes each section. The general conclusions are that: (1) West Hartford students are reaching high levels of achievement in mathematics and are developing positive attitudes toward mathematics; and (2) improvement is needed in the emphasis on application skills and in encouraging greater female participation in honors and advanced placement level mathematics courses. (MNS)

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AN EVALUATION OF MATHEMATICS

Edward F. Reidy, Jr.

December, 1984

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PURPOSE

This evaluation of mathematics is one of a series of program evaluations conducted on a cyclical basis. Its purpose is to provide information for program improvement and growth so that our students will become increasingly more adept in their use of mathematics.

QUESTIONS OF INTEREST

Our evaluation of mathematics has focused on the following questions:

1. To what extent are students learning the skills, concepts and generalizations in our math curriculum?
2. How does the achievement of our students compare with that of students across the country?
3. Are there achievement differences between females and males?
4. How many math courses do students typically take in their secondary school program?
5. Do females and males differ on the number of math courses taken?
6. How many students successfully complete honors and advanced placement level math courses?
7. Do females and males differ in the number of honors and advanced placement level math courses successfully completed?
8. What attitudes do students express towards mathematics?

FINDINGS

The rest of this paper is organized by questions or set of questions. Following the statement of question(s), we indicate the data used to answer the question(s) and the answers we found. At the end of each section there is a summary statement enclosed in a box.

SE 046 191

A. *To what extent are students learning the skills, concepts and generalizations in our math curriculum?*

How does the achievement of our students compare with that of students across the country?

Are there achievement differences between female and males?

The sources of data used in answering this set of questions include the Diagnostic Mathematics Tests (DMS), the Comprehensive Test of Basic Skills (CTBS), the International Eighth Grade Math Tests (IEA Math) and the Scholastic Aptitude Tests (SAT). The DMS is taken by virtually all students in the Fall and Winter of each year. The CTBS is taken by virtually all students in grades 4, 6, 8 and 10 each October. The IEA Math Tests were taken by all eighth grade students in the standard math course during the Fall and Spring of the 1981-1982 school year. The SATs are taken by eighty to ninety percent of each graduating class.

The DMS is a series of tests designed to measure many of the math skills, concepts and generalizations taught in each of grades 1 - 8. While there is a specific set of skill expectations for each grade, we recognize that not all youngsters will be working on grade level. Some will be working on a lower level set of skills; others, on a higher level.

Table 1 shows some dramatic changes in the percentage of students able to meet our grade level curriculum expectations. In the Fall of 1981, one of four elementary school and one of two middle school students was working below level. In the Fall of 1984, only 4% of our elementary school students and 8% of our middle school students were working below level. Since mean scores on these tests have not changed over that time period, we conclude the growth in the percentage of youngsters working on or above level is real, not a statistical artifact. Our students are learning the skills, concepts and generalizations measured by the DMS tests.

However, the DMS tests do not measure all of what we teach and expect students to learn. To determine whether students are learning skills not tested on the DMS tests, we looked at student scores on the Comprehensive Test of Basic Skills (CTBS). This test is a commercially published test used in school districts across the country. It measures a broad range of skills with two subtests, one called Computation and the other, Concepts and Applications. Scores on the CTBS provide an indication both of how well students are learning a broad range of skills and on how their achievement compares with that of students throughout the nation.

TABLE 1

PERCENTAGE OF STUDENTS TESTED BELOW EXPECTED GRADE LEVEL ON DMS

	YEAR			
GRADE	FALL, 1981	FALL, 1982	FALL, 1983	FALL, 1984
2	5%	3%	2%	2%
3	19%	4%	3%	2%
4	26%	15%	4%	4%
5	29%	17%	11%	3%
6	39%	22%	14%	7%
7	46%	38%	17%	11%
8	52%	37%	34%	5%
2-6	25%	13%	7%	4%
7-8	49%	37%	26%	8%

Table 2 shows the mean percentile rank for students in grades four, six, eight and ten in 1982, 1983 and 1984. From these data we conclude that our students are learning the broad range of skills tested in the CTBS and that our students' achievement compares very favorably with that of students across the nation, expecially at grade ten.

The data in Table 2 provide what is known as a cross-sectional view of student achievement. It allows us to compare the scores of students in grade four in 1982 with those of different students in grade four in 1983. It also compares students in grade four in 1982 with different students in grade six in 1982.

Another way to view student achievement is to compare the scores of the same students over time. Table 3 provides the data for such a longitudinal view. Data for three groups of students are shown in this table. The first group are students who were fourth graders in 1982 and sixth graders in 1984; the second group, sixth graders in 1982 and eighth graders in 1984; and the third group, eighth graders in 1982 and tenth graders in 1984. All students whose scores are represented in this table were in the West Hartford Schools from 1982 through 1984, so changes in their scores represent the best index of the effects of our instructional program.

An examination of the total math scores in Table 3 shows our students' scores rise impressively between 1982 and 1984. Clearly, our students are learning mathematics quite well. Furthermore, the achievement of the average student in West Hartford puts her or him in the top ten to twenty percent of students nationwide.

Looking at the subtest data in Table 3 we see that the largest score gains occur on the Computation Subtest. In fact on the Concepts and Application Subtest there is a substantial score drop for the grade 4 - 6 group. The 1984 data suggests that, relative to their nationwide peers, our students ability to compute is greater than their ability to apply their computational skills.

Tables 4A and 4B show the CTBS data for females and males. Clearly, these data do not show large achievement differences between females and males.

TABLE 2

COMPREHENSIVE TEST OF BASIC SKILLS

MEAN PERCENTILE RANKS

MATHEMATICS TOTAL

	GRADE			
	FOUR	SIX	EIGHT	TEN
Fall, 1982	78	74	77	83
Fall, 1983	76	71	77	84
Fall, 1984	77	79	77	87

TABLE 3

COMPREHENSIVE TEST OF BASIC SKILLS

LONGITUDINAL COMPARISONS WITH MEAN PERCENTILE RANKS

Group	Number of Students	Grade in 1984-1985	Computation 10/82	Computation 10/84	Concepts & Applications 10/82	Concepts & Applications 10/84	Total Mathematics 10/82	Total Mathematics 10/84
4-6	445	6	77	80	82	74	78	81
6-8	492	8	72	81	72	85	74	81
8-10	502	10	77	94	85	82	79	90

TABLE 4A

COMPREHENSIVE TEST OF BASIC SKILLS

LONGITUDINAL COMPARISON WITH MEAN PERCENTILE RANKS

FEMALES

Group	Number of Students	Grade in 1984-1985	Computation 10/82	Computation 10/84	Concepts & Applications 10/82	Concepts & Applications 10/84	Total Mathematics 10/82	Total Mathematics 10/84
4-6	220	6	78	82	81	70	78	79
6-8	235	8	76	83	70	84	78	81
8-10	249	10	79	95	85	80	79	91

TABLE 4B

MALES

4-6	225	6	76	74	84	79	79	82
6-8	257	8	66	80	72	85	73	81
8-10	253	10	75	93	85	83	77	90

Because of our participation in the Second International Mathematics Study, we have another measure of student achievement at the eighth grade level. From teacher questionnaire responses we know most of the objectives measured by these international math tests are taught in our eighth grade math program.

Table 5 shows the data for our standard math eighth graders. Students in modified math and in honors math did not participate in this study.

Clearly, comparisons of our students' scores with both international and national scores are very favorable. Our students' mean scores are higher than the United States mean on all five subtests and higher than the international means on four of the five subtests. On the Measurement Subtest the West Hartford and the international mean are identical.

Since these international math tests contain items measuring different skill levels, we can look at achievement by skill level. The data in Table 6, like the data in Table 3, show that our students' ability to compute is higher than their ability to apply and analyze.

The last set of data used in answering this set of questions is the SAT Math data. These data, summarized in Table 7, show that our students compare very favorably to their national peers and that score differences between females and males have existed in the nation and in West Hartford for many years.

Over the last eight years West Hartford's mean SAT Math score has ranged from 493 to 508. The difference between the national mean and our mean has ranged from 27 to 40 points. In 1984 West Hartford's mean score of 499 was 28 points higher than the national mean.

In every one of the last eight years the mean score for males, both in the nation and in West Hartford, has been substantially higher than the mean score for females. This difference between females and males in SAT scores contrasts with no difference on the CTBS (Tables 4A and 4B). However, it should be noted that the CTBS is an achievement test and the SAT, an aptitude test.

TABLE 5

THE SECOND INTERNATIONAL MATHEMATICS STUDY

Subtest Scores: Mean Percent of Items Correct

Grade 8

June, 1982

	United States	International	West Hartford
Arithmetic	51%	50%	61%
Algebra	43%	43%	52%
Geometry	38%	41%	49%
Probability and Statistics	57%	55%	66%
Measurement	42%	51%	51%

TABLE 6

THE SECOND INTERNATIONAL MATHEMATICS STUDY

Mean Percent Correct by Subtest and Skill Level

Grade 8 Standard Math Students

West Hartford, Connecticut

June, 1982

Subtest	Skill Level: Calculation and Comprehension	Skill Level: Application and Analysis
Arithmetic	65%	55%
Algebra	56%	44%
Geometry	50%	41%
Probability and Statistics	71%	37%
Measurement	57%	36%

TABLE 7

SCHOLASTIC APTITUDE MATHEMATICS SCORES

Graduating Classes of 1977 - 1984

	Female			Male			Total		
	N	$\bar{X}$	SD	N	$\bar{X}$	SD	N	$\bar{X}$	SD
1977	355	476 (445)	114	353	521 (497)	115	708	499 (470)	117
1978	357	476 (444)	109	359	541 (494)	117	716	508 (468)	118
1979	358	474 (443)	106	345	518 (493)	128	703	495 (467)	119
1980	349	486 (446)	111	287	513 (487)	126	636	498 (466)	119
1981	342	469 (443)	106	302	520 (492)	115	644	493 (466)	113
1982	325	474 (443)	108	324	522 (493)	120	649	498 (467)	117
1983	271	487 (445)	115	282	509 (493)	119	553	498 (468)	118
1984	258	476 (449)	112	284	519 (495)	127	542	499 (471)	122

NOTES: N = number of students taking the test

$\bar{X}$ = mean score

SD = standard deviation

( ) = national mean score

From the data presented above, we conclude that our students are learning the skills, concepts and generalizations in our mathematics curriculum quite well. On tests which allow us to compare their achievement to that of students throughout the country and throughout the world, West Hartford students compare very favorably. This is especially true for students who have been in our schools for a number of years.

We do not find significant differences in math test scores between females and males on the Comprehensive Test of Basic Skills at grades four, six, eight or ten. We do find that mean scores for males are higher than mean scores for females on the Scholastic Aptitude Mathematics Test.

B. *How many math courses do students typically take in their secondary school program?*

Do females and males differ on the number of math courses taken?

How many students successfully complete honors and advanced placement level math courses?

Do females and males differ in the number of honors and advanced placement level math courses successfully completed?

To answer these questions we used course data for the Class of 1984. In this class there were 286 females and 334 males. To graduate, these students needed to successfully complete two (2.0) math courses.

In examining the data on courses successfully completed by members of the Class of 1984, we found that the overall median was 4.0; for females, 3.5 and for males, 4.0. This means that the typical student completed four math courses, twice as many as he or she was required to complete for graduation.

Seventy-seven percent of the students in this class took more than the required two courses. Seventy-two percent completed three or more courses and 50% completed four or more courses.

Seventy-six percent of the females in this class and 78% of the males took more than the required two courses. Seventy-two percent of the females and of

the males completed three or more courses. Forty-eight percent of the females and 52% of the males completed four or more courses.

Nineteen percent of students in the Class of 1984 successfully completed at least one honors or advanced placement level math course. There were no differences between females and males.

Overall, 9% successfully completed four honors/advanced placement level courses. This figure represents 7% of the females and 11% of the males.

Fifteen percent successfully completed a calculus course. This represents 13% of the females and 17% of the males. In Calculus BC, the more advanced of the two calculus courses we offer, there are more than twice as many males as females. Five percent of the males in the Class of 1984 took Calculus BC; 2% of the females.

Clearly, both female and male students in West Hartford successfully take more math courses than are required for graduation. Furthermore, nearly one in five students takes one or more honors or advanced placement level courses.

Differences between females and males exist not in the number of math courses taken, but in the number of honors and advanced placement level math courses taken. In the more advanced level courses there are more males than females.

C. *What attitudes do students express toward mathematics?*

To answer this question we assembled a questionnaire for secondary school students from an item pool provided by the National Assessment of Educational Progress. We used items from this pool to measure student enjoyment of math, student confidence in their math ability, student anxiety about math, student perceptions of the usefulness of math, the extent to which students feel teachers encourage them in their study of math and student perception of whether boys and girls are treated differently in math classes. We also wrote some items to measure whether students feel challenged in their math classes. Once the questionnaire for secondary students was completed, we modified it for use in grades 3, 4, 5 and 6.

Students in grades 3, 4, 5, 6, 7, 9 and 11 completed their questionnaire in June, 1983. Reliabilities were computed for all subscales at each grade level. Those reliabilities indicated that all subscales were interpretable with one exception, the Challenge Subscale on the questionnaire for elementary school students. Accordingly, data for that subscale is not presented in this report.

Table 8 summarizes the attitude data for students in grades 3, 4, 5 and 6; Table 9, for students in grades 7, 9 and 11. The lowest possible score is 1.0; the highest, 5.0.

Elementary school students enjoy math and are confident in their math ability, more so at grade 3 than at grade 6. They see math as a useful subject and see their teachers very much encouraging them in their study of math. Their math anxiety is relatively low at all four grades and they do not see their teachers treating boys any differently than girls. While there are differences between male and female scores, those differences are small.

Students in grades 7, 9 and 11 also have favorable attitudes toward mathematics. Again, differences between females and males are small. The highest scores for these secondary students are on the Usefulness of Math, Teacher Encouragement and Challenge Subscales. Responses to the last subscale indicate that students do feel relatively challenged in their math classes.

TABLE 8

ATTITUDES TOWARDS MATH

Subscore Means

Grades 3, 4, 5 and 6

June, 1983

				Grade			
	Overall	Female	Male	3	4	5	6
Math Enjoyment	3.57	3.53	3.61	3.76	3.62	3.49	3.46
Math Confidence	3.80	3.71	3.88	3.98	3.84	3.74	3.68
Math Anxiety	2.19	2.27	2.12	2.00	2.17	2.27	2.28
Usefulness of Math	4.05	4.02	4.07	4.12	4.03	4.00	4.05
Teacher Encouragement	4.06	4.05	4.08	4.32	4.12	3.98	3.90
Differential Treatment	1.79	1.68	1.89	1.82	1.78	1.79	1.79
# of Students	2057	968	1089	442	530	486	599

TABLE 9

ATTITUDES TOWARDS MATH

Subscore Means

Grades 7, 9 and 11

June, 1983

				Grade		
	Overall	Female	Male	7	9	11
Math Enjoyment	3.15	3.07	3.19	3.19	3.11	3.16
Math Confidence	3.55	3.44	3.63	3.58	3.52	3.56
Math Anxiety	2.51	2.56	2.47	2.47	2.53	2.55
Usefulness of Math	3.97	3.93	4.03	4.13	3.93	3.81
Teacher Encouragement	3.70	3.68	3.69	3.68	3.75	3.66
Differential Treatment	1.99	1.88	2.07	1.89	2.02	2.07
Challenge	3.66	3.70	3.64	3.76	3.64	3.55
# of Students	1503	632	624	573	542	388

In short, data from student questionnaires indicate favorable student attitudes towards math. Given the high level of student achievement in math, positive student attitudes are to be expected.

CONCLUDING REMARKS

West Hartford students are reaching high levels of achievement in mathematics and are developing positive attitudes toward mathematics.

Opportunities to improve are in two areas. First, we need to consider a greater emphasis on application skills in math. Secondly, we need to encourage greater female participation in honors and advanced placement level math courses.